

## SECTION 13100

### LIGHTNING PROTECTION SYSTEM

\*\*\*\*\*

#### **LANL MASTER CONSTRUCTION SPECIFICATION**

Use this specification for structures that are NOT used for the storage or handling of explosives. Use Section 13101 for structures that are used for the storage or handling of explosives.

Edit this specification to suit Project requirements. Add project-specific requirements and delete those portions that do not apply to the work (e.g., a sub-system that does not apply). To seek a variance from applicable requirements, contact the LEM Electrical POC or the LANL Lightning Protection SME. Refer to

[http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc\\_techcom1.htm#elec](http://www.lanl.gov/f6stds/pubf6stds/engrman/HTML/poc_techcom1.htm#elec) for the Engineering Manual Personnel Link Index.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within "stars" during editing.

This specification developed for ML-3 / ML-4 projects. For ML-1 or ML-2 projects additional requirements and QA reviews are required.

\*\*\*\*\*

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

A. Furnish and install lightning protection system including the following:

1. Integral air terminal system to protect the structure.
2. Interconnecting lightning protection conductors.
3. Grounding and bonding for lightning protection.
4. Lightning protection grounding electrode system.
5. Surge arresters on all conductors entering the structure.

##### 1.2 LANL PERFORMED WORK

A. LANL will inspect the lightning protection system for acceptance.

##### 1.3 PERFORMANCE REQUIREMENTS

- A. Protect the entire building including roof projections, chimneys, roof mounted equipment, associated exposed structures, electrical services, antennas, alarm services, and telecommunications services.
- B. Design system based on a 150 ft lightning striking distance as defined in NFPA 780.
- C. Design grounding system to achieve a ground resistance of not over 25 ohms.

## 1.4 SUBMITTALS

- A. Submit the following in accordance with the requirements of Section 01330:
1. Catalog data for each component of the lightning protection system, including data substantiating that material complies with specified requirements. Include data for roof adhesive when used.
  2. Certifications demonstrating that firms meet qualifications specified in "Quality Assurance" Article to demonstrate capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.
  3. Materials list of lightning protection system components showing quantity and manufacturer's catalog number.
  4. Shop drawings, not smaller than 1/8" = 1'-0" scale, showing the type, size, and locations of counterpoise, ground rods, down conductors, through roof/through wall assemblies, roof conductors, air terminals, and bonding connections.
  5. Project record documents that accurately record actual locations of counterpoise, ground rods, down conductors, through roof/through wall assemblies, roof conductors, air terminals, and bonding connections.
  6. Test reports for all inspection and testing required by this Section.

## 1.5 QUALITY ASSURANCE

- A. Comply with NFPA 780 *Standard for the Installation of Lightning Protection Systems* and UL 96A *Installation Requirements for Lightning Protection Systems*.
- B. Engage a qualified installer to design and install the lightning protection system. Installer shall have either a current LPI Master Installer certification or current UL listing (Category OWAY) for Lightning Protection Installation. The installer shall have successfully completed not less than 5 lightning protection installations of similar scope to this project.
- C. LANL will inspect the lightning protection system for acceptance in accordance with NFPA 780 and UL 96A.
- D. Provide products that are NRTL listed for lightning protection use.

## 1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building materials, and metal bodies requiring bonding to lightning protection systems.
- B. Coordinate inspections so lightning protection conductors and bonding connections will be inspected and photographically documented before being covered with concrete or other building materials.

## 1.7 RECEIVING, STORING, AND PROTECTING

- A. Receive, store, protect, and handle products according to NECA 1 *Standard Practices for Good Workmanship in Electrical Construction*.
- B. Handle conductors to prevent nicking, kinking, gouging, flattening, or otherwise deforming or weakening conductor or impairing its conductivity.

## PART 2 PRODUCTS

### 2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Alternate products may be accepted, follow Section 01630, Products Options and Substitutions.

### 2.2 LIGHTNING PROTECTION MATERIAL

- A. Provide lightning protection materials and components that conform to NFPA 780 and UL 96 *Standard for Safety for Lightning Protection Components*.
- B. Provide lightning protection materials that are galvanically compatible with each other and with surfaces on which they are mounted or which they contact. In general use copper conductors and bronze fittings; use aluminum conductors and fittings only where required for galvanic compatibility.
  - 1. Metals acceptable for contact with copper include copper, nickel, brass, tin, lead, stainless steel, and Monel.
  - 2. Metals acceptable for contact with aluminum include aluminum, magnesium, zinc, galvanized steel, stainless steel, lead, and wrought iron.
  - 3. Provide conductors with protective coatings or oversize conductors where unusual conditions exist which would cause corrosion of conductors.
- C. Air terminals:
  - 1. Copper: Provide 1/2 inch diameter, rounded tip, solid copper air terminals.
  - 2. Aluminum: Provide 5/8 inch diameter, rounded tip, solid aluminum air terminals.
  - 3. Air terminal tips shall have a tip radius of curvature of 3/16 inch minimum to 1/2 inch maximum.
  - 4. Provide a base for each air terminal that matches the air terminal material, has a bolted pressure type cable connector, will support the terminal in a vertical position, and is suitable for the surface to which it will be attached.
- D. Conductors:
  - 1. Provide rope lay or braided smooth twist lightning protection cables as follows:

\*\*\*\*\*

**Edit the following article to match project requirements. If structure is more than 75 feet in height, change conductor to Class II material as described in NFPA 780.**

\*\*\*\*\*

2. Copper Main Conductor: Provide copper cable with minimum 17 AWG strand size and a minimum cross sectional area of 57,400 circular mils.
  3. Aluminum Main Conductor: Provide aluminum cable with minimum 14 AWG strand size and a minimum cross sectional area of 98,600 circular mils.
  4. Copper Bonding Conductor: Provide copper cable with minimum 17 AWG strand size and a minimum cross sectional area of 26,240 circular mils.
  5. Aluminum Bonding Conductor: Provide aluminum cable with minimum 14 AWG strand size and a minimum cross sectional area of 41,100 circular mils.
- E. Provide bolted pressure type connectors; finger, crimp, or pressure saddle style cable connectors are not acceptable.
- F. Provide adhesive for cable fasteners and air terminal bases that is compatible with surface or roofing material to which bases or fasteners are to be attached.

## 2.3 GROUNDING SYSTEM MATERIAL

\*\*\*\*\*

**Edit the following article to match project requirements; delete if not required.**

\*\*\*\*\*

- A. Ground Rods:
1. Provide NRTL listed ground rods as shown on the Drawings.
  2. Furnish ground rods that comply with ANSI C135.30 with high-strength steel core and electrolytic-grade copper outer sheath, molten welded to core, approximately 10 feet long, 3/4 inches in diameter.
  3. Manufacturers: Blackburn, Thomas & Betts, Harger.

\*\*\*\*\*

**Edit the following article to match project requirements; delete if not required.**

\*\*\*\*\*

- B. Chemical Ground Rods:
1. Provide UL listed chemical ground rod(s) as shown on the Drawings.
  2. Furnish chemical ground rods fabricated from Type K copper tubing approximately 10 feet long, 2 inches in diameter containing a hygroscopic electrolyte material. Furnish each chemical ground rod with a 24 inch long #4/0 copper pigtail, threaded removable cap, a protective cover box, and Bentonite clay backfill material.
  3. Manufacturers: Harger CGR Series, Lyncole Industries, Inc., LEC Inc., Superior Grounding Systems.

C. Ground Cable:

1. Provide bare stranded, soft temper copper cable that conforms to ASTM B8, *Standard Specification for Concentric-Lay Stranded Copper Conductors*.
2. Provide cable size as indicated on the Drawings or specified in this Section, 1/0 AWG minimum.

D. Ground Electrode Backfill Material:

1. Provide a Bentonite clay or equivalent commercial ground enhancement backfill material for ground rods and cable type electrodes.
2. Backfill material, when at 300% moisture content (weight of water/weight of material)x (100), shall have a resistivity of approximately 250 ohm-cm and a pH of 8 to 10.
3. Manufacturers: WYO-BEN Inc, ERICO

E. Bolted Ground Connectors:

1. Provide NRTL listed copper alloy bolted connectors with silicon bronze hardware for making cable connections to pipes, ground rods, exposed structural steel, roof deck, and wall panels.
2. Manufacturers: Blackburn, Burndy, O.Z.

F. Exothermic Weld Connections:

1. Provide molds and welding material in kit form for making exothermic weld connections.
2. Match mold and weld material to material types, shapes and sizes to be joined.
3. Manufacturer: ERICO Cadweld.

G. Compression Grounding Connectors:

1. Provide NRTL listed wrought copper connectors, terminals and splices for making compression grounding connections on concentric lay ground electrode cable and bonding connections to reinforcing steel.
2. Furnish connectors that have been tested successfully according to the requirements of IEEE Std. 837 - *IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding*.
3. Provide hydraulic compression tools and dies that match the connectors.
4. Match connector and die size to material shapes and sizes to be joined.
5. Manufacturer: Blackburn, Burndy.

## 2.4 SURGE SUPPRESSORS

\*\*\*\*\*

**Include and edit LANL Construction Specification Section 16289 to match Project requirements.**

\*\*\*\*\*

- A. Provide surge suppressors for all power, control, and communications conductors entering the building.
- B. Refer to Section 16289 *Surge Protective Devices*.

## PART 3 EXECUTION

\*\*\*\*\*

**Delete the following article when existing construction is not affected.**

\*\*\*\*\*

### 3.1 EXISTING WORK

- A. Disconnect and remove abandoned lightning protection system components.
- B. Existing lightning protection material and components that meet the requirements of this Section and are in good condition may be re-conditioned and re-used. Re-conditioning includes removal of adhesive, removal of corrosion, and wire brushing contact areas.
- C. Inspect, test, and repair the parts of the existing lightning protection system on the structure that are to remain in service. Use test instruments that are capable of measuring within plus or minus 10 percent of the required reading and have current calibration. Provide certified test results and instrument calibration information to the Contract Administrator.
  - 1. Make continuity tests of concealed parts of existing systems that may be re-used and are not available for visual inspection.
  - 2. Perform continuity tests to verify that electric service(s), telecommunications service(s), antenna system grounds, and underground metallic piping systems are bonded to the existing lightning protection system.
  - 3. Perform ground-impedance measurements of existing lightning protection grounds to verify that ground resistance is less than 25 ohms.
    - a. Perform ground resistance measurements with the lightning protection ground system temporarily disconnected from all other grounding and piping systems.
    - b. Use the "fall-of-potential" method in accordance with IEEE 81 *Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System*. Use instrumentation specifically designed for ground impedance testing as defined in Section 12 of the above guide. Provide sufficient spacing of test electrodes so that the plotted curves flatten in the 62% area of the distance between the item under test and the current electrode. When sufficient spacing of electrodes is impractical for the "fall-of-potential" method, perform ground-impedance measurements using either the "intersecting curves method" or the "slope method", references 40 and 41 in IEEE Std. 81.
    - c. If the lightning protection ground system resistance exceeds 25 ohms, add ground rods, plates, or other approved electrodes to obtain 25 ohms or less.

- D. Visually inspect existing surge suppression devices on electrical services, electrical circuits, and communications, alarm, control, and antenna systems for indication of damage. Replace missing or damaged surge suppression devices.

### 3.2 EXAMINATION

- A. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION - GENERAL

- A. Install lightning protection system according to NFPA 780, UL 96A, the *NEC*, as specified in this Section, and as shown on the Drawings.
- B. Install lightning protection components according to the manufacturer's written instructions.
- C. Install air terminals on ridges, parapets, and around the perimeter of buildings with flat roofs at spacing not to exceed 20 feet. Install supplemental air terminals as required by and NFPA 780. Permanently and rigidly attach air terminals to prevent overturning.
- D. On single-ply roofing use adhesive recommended by manufacturer of the adhesive air terminal bases and approved by manufacturer of the roofing material. Comply with adhesive manufacturer's installation instructions.
- E. Install roof conductors so they will be visible for inspection and testing.
- F. Install down conductors at locations compatible with the building structure and architectural design with consideration given to the location of ground connections and air terminals.
  - 1. Course exposed down conductors over the extreme outer portions of the exterior of the building, such as corners.
  - 2. Install concealed down conductors on building structural columns. Make connections from roof conductors to down conductors on parapet walls; avoid using through-roof connectors.
- G. Install an accessible down conductor disconnect in each down conductor except the one nearest the building electrical service entrance; use 4-bolt tubular splice fittings.
- H. Cover down conductors that are subject to physical damage or displacement with Schedule 80 PVC conduit. Cover down conductors from grade level up to 6 ft above grade. Support conduit with conduit clamps spaced not more than 36 inches apart.

\*\*\*\*\*

**Edit the following article to match project requirements.**

\*\*\*\*\*

### 3.4 LIGHTNING PROTECTION GROUNDING ELECTRODE SYSTEM

- A. Counterpoise Electrode: Install a counterpoise ring around the building or structure. Use minimum 1/0 AWG ground cable located 5 ft outside the building perimeter and at least 6 ft from any electrical system or communications system grounding. Install the counterpoise at least 3 ft below grade. Encase the counterpoise in a 2 inch envelope of ground electrode backfill material slurry.
- B. Other Made Electrodes: Where it is not possible to install a counterpoise ring as the lightning protection ground, or the ground must be supplemented, install one or more ground rods located 5 ft outside the building perimeter and at least 6 ft from any electrical system or communications system grounding. Install ground rods in 6 inch diameter augered holes with at least 10 ft separation between rods. Backfill hole with a slurry of ground electrode backfill material.
- C. Connect the counterpoise to the main grounding electrode ground bar located near the building electrical service entrance. Interconnections to electrical power, telephone, and piping systems will be made at the main grounding electrode ground bar.

### 3.5 LIGHTNING PROTECTION CONNECTIONS

- A. Clean contact surfaces to which lightning protection connections are to be made. Remove non-conductive coatings such as paint, enamel, and oil film.
- B. Use the following connection methods:
  - 1. Use exothermic weld connections for underground or concealed connections of dissimilar materials.
  - 2. Use exothermic weld or compression grounding connections for underground or concealed connections of like materials. Do not use compression grounding connectors for rope lay lightning conductor connections or for lightning protection ground rod connections.
  - 3. Use exothermic weld or bolted connections for accessible connections.
  - 4. Use high strength silicon bronze bolts, nuts, flat washers and toothed lockwashers for making bolted connections.
- C. Tighten lightning protection connectors, screws and bolts in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with UL 486A and UL 486B. Use a calibrated torque wrench.
- D. Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed.
- E. Install exothermic welds in accordance with manufacturer's instructions and recommendations. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.



- F. Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer in order of galvanic series.
  - 2. Make connections with clean bare metal at points of contact.
  - 3. Make aluminum to steel connections with stainless steel separators and mechanical clamps.
  - 4. Make aluminum to galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Protect lightning protection connections to prevent them from being painted or covered with material such as fire proofing or roofing adhesive.

### 3.6 SURGE ARRESTER INSTALLATION

- A. Refer to Section 16289 *Surge Protective Devices*.
- B. Perform arrester installation only on de-energized equipment.
- C. Schedule service de-energizing with Facility Manager.
- D. Arrange for the installation of new primary protectors on telecommunications circuits where suitable protectors are missing or damaged.
  - 1. Coordinate installation with the LANL Telecommunications Group.
  - 2. Provide suitable ground connection for the telecommunications primary protectors.

### 3.7 FIELD QUALITY CONTROL

- A. Use test instruments that are capable of measuring within plus or minus 10 percent of the required reading and have current calibration.
- B. Test the lightning protection grounding electrode system using the "fall of potential" method. Make test at least 30 days after installation of the electrode and before any connections are made to the electrode. Verify that resistance to earth reading is 25 ohms or less. Supplement grounding electrode if resistance exceeds 25 ohms. Use test instruments that are designed specifically for earth resistance testing. Provide certified test results and instrument calibration information to the Contract Administrator.
- C. Inspect and test the lightning protection system to determine:
  - 1. That the system complies with the current requirements of NFPA 780.

2. That all required bonds are in place and are secure.
3. That all AC power lines, communications, and data lines that enter the facility have surge suppression devices that are properly installed and functional.

Take corrective action to correct deficiencies. Provide certified inspection and test results and instrument specifications and calibration information to the Contract Administrator.

- D. An inspection of the lightning protection system will be conducted by the LANL Contract Administrator prior to system acceptance.
  1. Primary protection system
  2. Down conductors
  3. Grounding system ground resistance.
- E. Notify the Contract Administrator 10 working days in advance of the expected completion of the lightning protection system installation. Inspection can be scheduled in parts or by area depending on the system and construction schedule.
- F. Promptly correct all deficiencies as required by the Contract Administrator.

END OF SECTION

\*\*\*\*\*

**Do not delete the following reference information.**

\*\*\*\*\*

FOR LANL USE ONLY

This project specification is based on LANL Master Construction Specification Section 13100 Rev. 0, September 17, 2004.